STO S: Physical Training Methods to Enhance Military Task Performance and Reduce Musculoskeletal Injuries

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Problem

- There is no standardized training to safely achieve and maintain optimal physical task performance
- Injuries impact soldier readiness
- Occupationally-related injuries may be due to inadequate strength, over-training, or both
- 23 to 67% of soldiers in Army BCT are injured
- Stress fracture incidence in BCT in women is >2 times that of men
- BCT injuries associated with low physical fitness

Goal: Physical training and monitoring strategies to achieve a high level of physical readiness while minimizing injury rates

Objectives

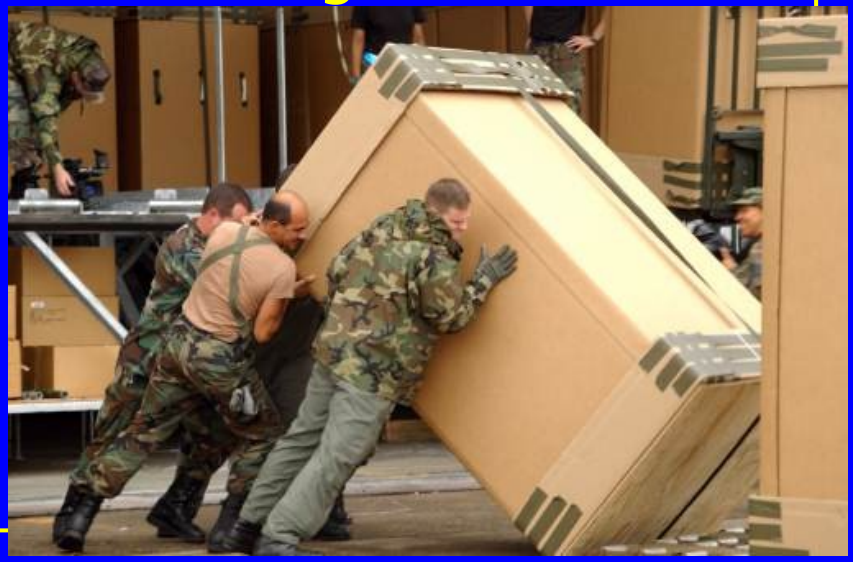
- Provide effective, science-based physical training strategies to efficiently achieve the highest possible level of physical readiness while minimizing injury rates
- Identify biomarkers to measure physiological strain and predict increased susceptibility to injury during physical training

Payoff

- Effective, efficient physical training procedures
- Field expedient measures of warfighter metabolic status
- Improve soldier occupational performance
- Fewer training injuries
- Reduced attrition due to training injuries
- Increased soldier physical readiness

Challenges

- Lack of validated physical readiness predictors
- Lack of validated injury risk predictors
- Laboratory training models have not been transitioned for field validation
- Lack of reliable markers of over-training
- Inadequate medical surveilla technologies
- Invasiveness of biomarker collection methods



Performers and Partnerships

- US Army Research Institute of Environmental Medicine, Natick, MA
- US Army Center for Health Promotion and Preventive Medicine, Aberdeen Proving Ground, MD
- US Army Physical Fitness School, Ft Benning, GA

- UCONN, CT & Springfield College, MA (Training site, research collaborators)
- USARIEM/Womack Medical Research Facility at Fort Bragg

Funding

Programmed:

	FY03	FY04	FY 05	FY06	FY07
($M)	.80	.95	1.10	1.30	1.40

Leveraged:

- STO Z Joint Load Carriage to fund load bearing training study ($150K)
- Special appropriations for Bone Health Research ($240K)

Development of an Occupational Task Battery

Purpose: Develop militarily-relevant tests of physical performance for use as outcome measures during training studies

Proposed Tasks:

- Casualty Drag (FM 4-02.4)
- Entrenchment (FM 7-8)
- Load Carriage (FM 21-18, FM 7-10)
- Maximal Lift onto a 5-Ton Truck
- Repetitive Lifting onto a 5-Ton Truck
- 30-Meter Combat Rushes (FM 21-18)
- Running Long-Jump with Fighting Load
- Grenade Throw (FM 3-23.3.0, FM23-31)
- Obstacle Course (FM 21-20)

Progress: Developed task concepts, protocol in preparation, conduct feasibility and reliability testing in 2003

Proposed USARIEM study: Ms. Marilyn A. Sharp, Principal Investigato

Job Performance and Injury Rates of MOS 63B, Light-Wheel Vehicle Mechanic, as a Function of Physical Fitness

Purpose

Do physical mismatches occur within MOS and what are the consequences?

Study Components

- **Ergonomic Job Analysis** (USA*CHPPM)*
- **Physical Performance Assessment** *(USARIEM)*
- **Injury Epidemiology** *(USACHPPM)*

Final Products

- Identify MOS specific injury rate and risk factors
- Identify common causes of injury
- Identify requisite strength and body composition for success in MOS
- Task-specific PT procedures to improve MOS performance

Planned USARIEM study, Ms. Marilyn A. Sharp, Principal Investigato

Physical Training Effects on Task Performance

- Resistance training is effective in improving soldier performance:
  - *Load carriage: 4-24%*
  - *1RM box lift: 13-30%*
  - *10 min box lift: 17-28%*

PHOTO 3

- Previous physical training studies difficult to implement due to:
  - Long train-up time
  - High frequency long daily duration
  - Sophisticated equipment
  - Small group or individualized training

Evaluating Physical Training Programs for Improving the Load Carriage Ability of Soldiers

Purpose

Determine the effect of three physical training programs on load carriage

Design

Compare three 8-week training programs

- Typical Army PT
- Innovative PT – unlimited equipment
- Innovative PT – no weights or machines

Outcome Variables (pre- post 8 wks)

- Occupational Task Battery
- Timed Load Carriage Tests
- VO2max, Strength and Power Output
- Hormonal response to exercise (GH/IGF-
- Biomechanical efficiency
- Static and dynamic balance

Planned USARIEM study, Dr. Everett A. Harman, Principal Investigato

Effects of Physical Training on Bone Remodeling

Purpose

- To provide new insight into the early-phase adaptations to physical training with a specific focus on bone remodeling

Design

- 4 groups of 20 women: control, aerobic, resistance, combined training
- Training 2-3 sessions/wk for 12 weeks
- In collaboration with University of Connecticut-Storrs

Outcome Variables (Measurements obtained at 0, 6 and 12 weeks)

- Strength, power and occupational test battery
- GH/IGF-I system
- Bone Health (trabecular & cortical bone, BMD & BMC)
- Bone Biomarkers (bone alkaline phosphate, TRAP, DPD, & helical peptide)

Planned USARIEM study, Dr. Bradley Nindl, Principal Investigator

Predicting Injury Susceptibility in Army Basic Training Recruits Using Field Expedient Biomarkers

Purpose Determine if selected biomarkers can be used to predict susceptibility to lower extremity physical training injuries

Design

Pre- Post 9 weeks of BasicTraining

Outcome Variables

Test Battery:

- Bone turnover (DPD, HP)
- Bone quantity, geometry, density
- pQCT
- Dynamic foot analysis
- Anthropometrics
- Thermography

Injury surveillance

Proposed USARIEM study, MAJ Rachel K. Evans, Principal Investigato

Polymorphisms and Susceptibility to Rhabdomyolysis

Purpose: **Identify predisposing factors (genetic and secondary) for rhabdomyolysis**

Design: **Blood samples drawn from 150 cases of rhabdomyolysis and 150 matched controls**

Deliverables:

1. Genetic profile to identify polymorphisms associated with high responders

2. Develop a treatment algorhythm based on profiles of patient responses.

Proposed USARIEM study, MAJ Rachel K. Evans, Principal Investigator

STO S Accomplishments

- **63B study data collection to begin Mar 2003, delayed due to volunteer availability**
- **Submitted three protocols for scientific and human use review:**
  - Effects of Physical Training on Bone Remodeling
  - Evaluating Physical Training Programs for Improving the Load Carriage Ability of Infantry Soldiers
  - Polymorphisms and Susceptibility to Rhabdomyolysis
- **Two protocols being prepared for submission:**
  - Development of an Occupational Performance Task Test Battery
  - Predicting Injury Susceptibility in U.S. Army Basic Training Recruits
    Using Field Expedient Biomarkers

Warfighter Physiological Status Monitoring

OBJECTIVES

- Generate operationally relevant *performance and health status indicators* for use by commanders and medical personnel

- Provide a warfighter acceptable, *wear and forget, physiological monitor* for use in both training and military operations

- *Maximize warfighter operational effectiveness and prevent casualties* by integrating predictive modeling with real-time physiological monitoring

- *Detect wounding*, determine live/dead status, and provide guidance for remote triage when integrated with a digital medic capability

Initial Core Requirements

US Army Infantry School and AMEDD Center and School

Remote Triage:

- **Life Sign Detection**

Force Health Protection Monitoring:

- **Thermal Stress (Hypo/Hyperthermia)**
- **Sleep/Cognitive Status**
- **Metabolic Status/Energy Reserves**

Warfighter Physiological Status Monitoring

Pre-Planned Product Improvement (P^3I)

US Army Infantry School and AMEDD Center and School

Remote Triage:

- Hemorrhagic Shock
- Respiratory Distress/Function
- Neurological Function

Force Health Protection Monitoring:

- Hydration State
- Mental Alertness Status
- Altitude Adaptation
- Chemical/Biological Agent Exposure
- Wound Alert

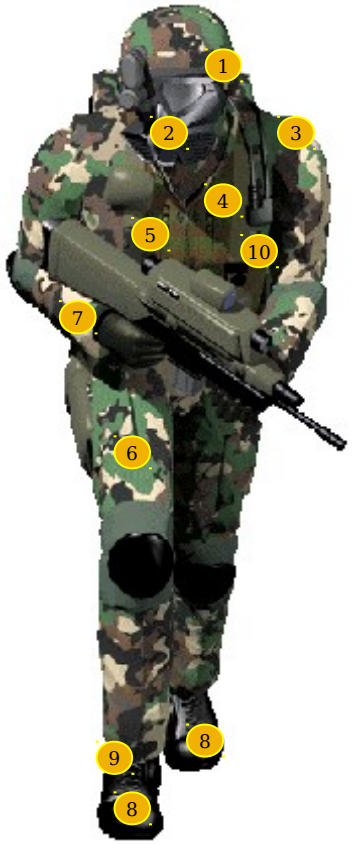
Warfighter Physiological Status Monitoring Concep

"Tool Kit" to Understand Warfighter Physiology

CURRENT

SENSORS/MEASUREMENTS

1. Headband EEG and Oximetry
2. Acoustic*
(Voice Stress and Content Analysis)
3. Dead Reckoning Module
(3-Axis Accelerometer, GPS, Magnetometer, Altimeter)
4. EKG, EMG, and Thoracic Impedance Cardiography
5. Body Core and Skin Temperature
6. Near-Infrared (or Other) Technology*
Tissue pH, Glucose, and Lactate
7. Wri
8. Boot
9. Foot Contact (Weight/Locomotion)



PHYSIOLOGICAL CONSEQUENCES OF CONCERN

Hypothermia
Hyperthermia
Hypoxia
Metabolic Fatigue
Vigilance Lapses
Dehydration
Psychological Stress
Inadequate Restorative Sleep
Desynchronization of Circadian Functions
Jolt, Blast, and Repeated Impact Exposure
Toxic Substance Exposure

Predict Significant Performance Degradation and Impending Casualty/ Immediate Casualty Care

FUTURE

** Concept*

Specifications for Minimal Sensor Set to Predict Warfighter Physiology

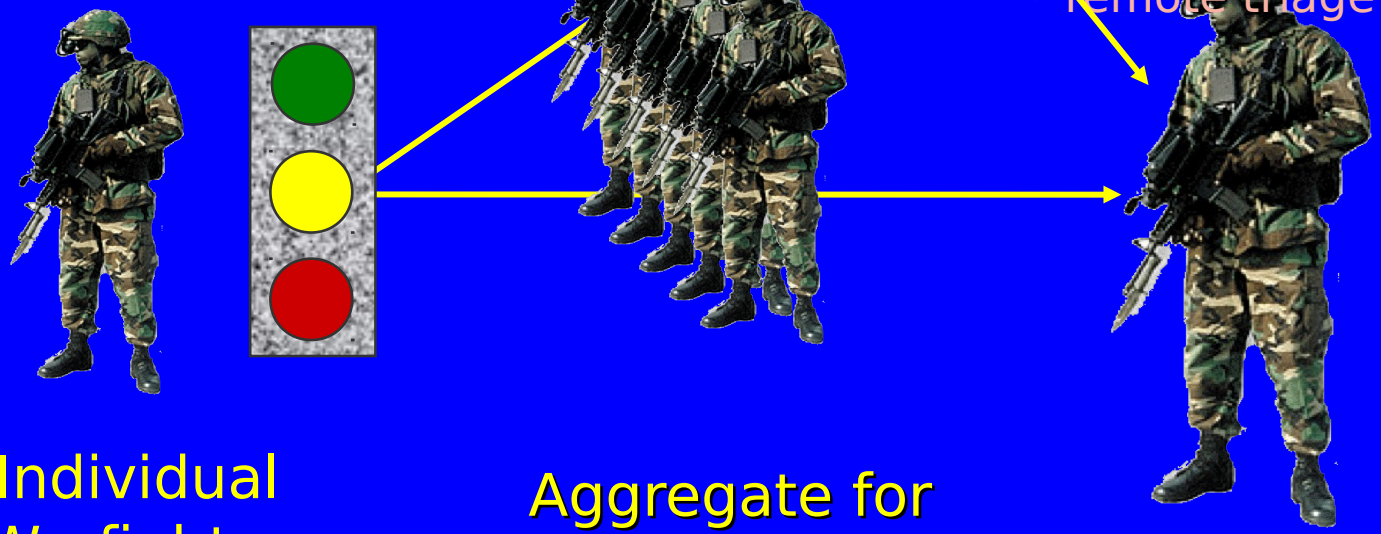
Warfighter Physiological Status Monitoring

EMPLOYMENT CONCEPT

Medic

- monitor health state
- casualty detection/ location
- remote triage

Physiologic Information



Commander

Individual Warfighter Status

Aggregate for Unit Status

Enhanced

- ✔ *Force Health*
- ✔ *Survivability*
- ✔ *Lethality*